Factors influencing uptake of antenatal-integrated HIV testing in Nigeria: Applying the Andersen behavioural model using a multilevel analysis approach

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Abstract

Background: Despite the integration of HIV testing into antenatal care and its increasing availability in Nigeria, its utilisation remains unacceptably low. This study aims to understand factors associated with uptake of antenatal HIV (ANC-HIV) testing among pregnant women in Nigeria. Using the Andersen behavioural model of health care utilization adapted to the context of HIV testing, the study specifically intends to identify the predisposing, enabling, need and HIV stigma (PENS) determinants of ANC-HIV testing use in Nigeria.

Methods: A multilevel logistic regression analysis is modelled using the 2013 Nigeria Demographic and Health Survey with a sample size of 5,164 pregnant women who gave birth between 2011 and 2013, attended ANC during the pregnancy and were offered HIV testing.

Findings: Results indicate that ANC-HIV testing use is nested within communities and states and that the determinants of ANC-HIV testing uptake include the predisposing (religion and HIV knowledge), enabling (wealth, bargaining power, partner's education, pre-test HIV counselling and place of ANC visit) and need (HIV risk perception) factors. The results also reveal that HIV stigmatising attitude towards PLWH/A is not an independent determinant of ANC-HIV testing uptake in Nigeria especially when other model factors like pre-test HIV counselling, HIV knowledge, wealth and women's education are controlled for.

Conclusion: The enabling factors dominate the determinants of ANC-HIV testing uptake in Nigeria and the general study findings are suggested for adoption into policies which aimed at enhancing the prevention of mother-to-child HIV transmission (PMTCT) programmes in the country.

Keywords: *ANC-HIV testing, pregnant women, Andersen behavioural model, multilevel logistic regression analysis, PMTCT, Nigeria*

Background

Globally, an estimated 35.3 million [32 200 000 - 38 800 000] people across all ages are living with human immunodeficiency virus (HIV), of which 70% reside in sub-Saharan Africa (SSA) only (UNAIDS, 2013). Likewise, despite the fact that 12.7% of the world population reside in the SSA (PRB, 2014), 9 out of every 10 HIV infected pregnant women and children (less than 15 years) are in the African sub-region (WHO, 2011; UNICEF, 2015). The PRB (2014) estimates put Nigeria as the most populous African country, occupying about 19.3% of the total SSA population. This indicates that nearly one out of every four sub-Sahara Africans is a Nigerian.

In Nigeria, the first case of AIDS was officially reported in 1986 and the spread of the HIV has since been growing exponentially. With national prevalence of 3.4 (NACA, 2014), recent report shows that about 3.1 million people are living with HIV in the country (UNAIDS, 2013). Followed by India, Nigeria is therefore ranked second highly HIV burdened country after South Africa in the world (WHO, 2011; UNAIDS, 2013). Recent trend estimates show that the total number of HIV positive children in Nigeria increased from 360,000 in 2009 (UNICEF, 2010) to 430,000 in 2012 (UNAIDS, 2013). Besides, with an estimated 51,000 new child HIV infections in 2013, Nigeria is therefore reportedly having the highest number of children who are contracting HIV in the world (UNAIDS, 2014a). About 90% of these positive Nigerian children contract the HIV infection through mother-to-child transmission - MTCT - (Agboghorom et al., 2013) either during pregnancy, birth or lactation period. This is not unexpected since only 27% out of the approximately 190,000 positive pregnant women in Nigeria receive antiretroviral (ARV) drugs to prevent mother to child transmission of HIV (UNAIDS, 2014a), making the risk of MTCT in the country to stand at 26%, the third largest after Chad and Democratic Republic of the Congo (UNAIDS, 2014a).

To ensure the prevention of mother to child transmission (PMTCT) of HIV, the WHO supported four comprehensive PMTCT prongs which are the "primary prevention of HIV infection among women of childbearing age, preventing unintended pregnancies among women living with HIV, preventing HIV transmission from a woman living with HIV to her infant and providing appropriate treatment, care and support to mothers living with HIV and their children and families." (WHO, 2010, p.6). According to UNICEF (2015), absence of such intervention programmes will expose between 15-45% of new-borns of positive women to HIV infection and about half of them will not live to celebrate their second birthdays. Incorporation of HIV testing into antenatal care (ANC) settings becomes central to the integration component of 2010 WHO strategy which aims at maximizing the prevention and care programmes for HIV-positive women and children (WHO, 2010). HIV testing is the gateway to accessing PMTCT and antiretroviral therapy (ART) programmes not only in Nigeria (FMoH, 2010; Odimegwu et al, 2013) but also across the globe (Staveteig et al. 2013; UNICEF, 2015). During the antenatal HIV counselling and testing, pregnant women are informed about HIV/AIDS, MTCT, and are offered a HIV test on voluntary and confidential bases. This therefore helps to identify those in need of post-HIV test follow-up for necessary PMTCT prongs and ART services. Hence, scaling up utilization of HIV testing during ANC is very crucial for PMTCT programmes in the Nigeria and elsewhere.

However, despite the various national and international efforts which aim at reducing the incidence of MTCT by increasing the availability of antenatal HIV testing service and other PMTCT interventions, evidence has shown that utilization of antenatal HIV testing is unacceptably low in Nigeria. Latest findings showed that only 28% of the pregnant women attending ANC were tested for HIV as against 61% who accessed the ANC in Nigeria (NPC & ICF International, 2014). Also, about 30% coverage of PMTCT was estimated in 2014 in the country (NACA, 2014). Both the reported antenatal HIV testing and PMTCT rates remain far short of the 90% desirable targets adopted in the country (FMoH, 2010; NACA, 2014). Similarly, the attainment of the United Nations global plan for the elimination of MTCT (eMTCT) which aims at reducing the MTCT rate to 5%, decreasing the paediatric HIV by 90% as well as with a target of 90% coverage of HIV-infected mothers receiving perinatal ARV by 2015 (UNAIDS, 2014a; UNICEF, 2015) in Nigeria is greatly undermined and shrouded in uncertainty. It is therefore instructive to identify the factors responsible for use and non-use of HIV

testing offered as part of antenatal care in order to fast tract the attainment of future targets such the 90-90-90 targets by 2020 and 95-95-95 targets by 2030, each of the 90s representing the anticipated coverage on HIV testing, treatment of the positive cases and viral suppression respectively (UNAIDS, 2014b). Knowledge of such facilitating and hindering factors will help to inform the Nigerian government and other concerned local and international stakeholders to devise programmes and policies that will help to scale up the antenatal HIV testing service utilization and thereby enhance the PMTCT programmes in the country. No doubt, progress in PMTCT programmes in Nigeria is essential to MTCT eradication globally.

In recent years, a handful of studies have focused on understanding the antenatal HIV testing and other MTCT-related issues in Nigeria. However, most of them are hospital-based in a particular locality or region of the country and conclusions are drawn mainly from descriptive analyses (Igwegbe, 2005; Ogaji et al., 2008; Moses et al., 2009; Okeudo, 2012; Olugbenga-Bello et al., 2012). The only study, to the best of our knowledge, which used a nationally representative data did not focus on ANC-HIV testing but rather on the Nigerian couples (Lepine et al., 2014). Therefore, considering the demographic and geographical dynamics of Nigeria including the observed wide variations in HIV prevalence across states and regions, there is need to understand the correlates of HIV testing uptake from a truly nationally representative data repository. To fill this gap, data from the most recent 2013 Nigeria demographic and health survey (NDHS) is sourced in this study, using a multilevel mixed effects modelling.

Several theoretical frameworks for explaining health care utilization have been documented in the literature (Ricketts & Goldsmith, 2005; Rebhan, 2011). One of the most inclusive and widely applied is the Andersen behavioural model of health care use (Philips et al., 1998; Ricketts & Goldsmith, 2005; Babitsch et al., 2012; Heider et al., 2014; Chomi et al., 2014). Based on the reviewed literature, this study seems to be the first to apply the Andersen behavioural model to the utilization of HIV testing especially as part of antenatal care. The model is conceptualised based on the predisposition, enablement and need for health care use (Andersen, 1995). The predisposing factors usually consists of the personal attributes of an individual which include the demographic (i.e. biological factors e.g. age and sex), social (i.e. education, ethnicity, employment) and health belief (i.e. values, knowledge and attitudes towards health and illness e.g. HIV/AIDs knowledge) characteristics. The enabling factors, which mainly comprises of contextual but sometimes personal characteristics, represents the ability to use health care service such as the availability and accessibility of the service, income level and household bargaining power among others. This indicates that the Andersen model is a contextual framework (Babitsch et al., 2011). The need factors pertain to both the perceived and evaluated assessment of one's health status which may inform the need for seeking health care. In this study, the need factors are conceptualised as risk behaviour and risk perception of HIV which is in line with previous applications of the model (Brown et al., 2009; Babitsch et al., 2011) and based on past studies on HIV testing use **(**De Paoli et al., 2004; Sambisa, 2008; Liu &Becker, 2008; Pharris et al., 2011; Ayiga et al., 2013; Lepine et al., 2014). Based on the literature reviewed in this study, no previous study has applied this theoretical model to examine uptake of HIV testing especially the antenatal- integrated testing. In this paper, HIV stigma factor – as a major barrier factor to HIV testing - is introduced as the forth model factor, in addition to the default predisposing, enabling and need factors. More detailed explanation about the Andersen model adaptation into the context of HIV testing use has been documented elsewhere (Adebayo, 2015).

The aim of this study is therefore to understand factors influencing uptake of HIV testing as part of antenatal care ("ANC-HIV testing" hereafter) among pregnant women in Nigeria. Based on the (adapted) Andersen behavioural model, we are interested in explaining the influence of predisposing, enabling, need and HIV stigma (PENS) factors on the ANC-HIV testing utilization in Nigeria. The use of the multilevel analysis affords the examination of contextual variations in the use of ANC-HIV testing in the study. In the second section below, the data and methods used are described while the results are presented in third section. The results are discussed in section four and the study conclusion as well as recommendations are provided in the last section.

Data and methods

Study design

The 2013 Nigeria Demographic and Health Survey (NDHS) is the main data source in this study. The 2013 NDHS is the fifth round and the most recent demographic and health surveys (DHS) conducted in Nigeria; the earlier NDHS were carried out in years 1990, 1999, 2003 and 2008 calendar years (NPC & ICF International, 2014). The 2013 NDHS is a cross-sectional and nationally representative survey covering retrospective information between 2008 and 2013. Due to the high geographical decentralization of the country such as from the national level to regions, states, localities and enumeration areas (EAs), a stratified three-stage cluster sampling design was used during the 2013 survey. The list of the EAs used during the survey was developed during the latest 2006 population and housing census exercise in the Nigeria. At the first stage of the sampling design, each state in the country was stratified into urban and rural areas and an independent selection of 893 localities in each stratum was made. At the second stage, a random selection of one EA was made from the majority of the selected localities. However, more EAs were selected in a few bigger localities making a total of 904 EAs (or clusters) in all. The 2013 NDHS regarded each EA as a cluster, which constitutes the primary sampling units (PSU). The total of 372 and 532 EAs or clusters were selected in urban and rural areas respectively, making a total of 904 clusters. Each cluster was made up of at least 80 households. A selection was however made from a contiguous EA in a situation whereby the selected EA had less than 80 households. In the third stage, 45 households were randomly selected each from all the selected rural and urban clusters through a systematic probability sampling. Detailed descriptions of the 2013 NDHS survey design, settings and data collection have been reported elsewhere (NPC & ICF International, 2014).

Asides, the information on HIV prevalence rate across the Nigerian states including the federal capital territory was obtained from the 2012 National HIV and AIDS and Reproductive Health Survey (NARHS) and was added to the 2013 NDHS working dataset for analysis purpose. Like the 2013 NDHS, the 2012 NARHS is a nationally representative survey which is conducted in every two years to provide information mainly on HIV & AIDS and reproductive health issues. Further details about the NARHS survey are provided FMoH, (2013).

Study sample

A sum of 38, 948 women were covered in the 2013 NDHS (NPC & ICF International, 2014). Though the retrospective and nationally representative information obtained in the survey spanned through a period of five years before the survey (2008-2013), sample selection for this study was first of all restricted to 14,220 women who gave birth in the last two years (2011-2013). This selection criteria was chosen in order to ensure comparability with previous related studies (Staveteig et al., 2013; Semali et al., 2014) and also to minimize the likely recall error on key and sensitive information. Since this study focuses on the utilization of HIV testing as part of ANC, only 9,321 women who attended ANC while pregnant (66%) in the last two years were further selected. Also, since the availability of ANC-HIV testing usually precedes its uptake, the final sample size used for data analysis in this study included only 5,164 pregnant women (36.32%) who were offered the HIV testing during their ANC attendance for their last birth in the last two years (2011-2013). The sampling selection procedure is depicted in Figure 1. The 27.27% (of the total 14,220 women) who were tested for HIV and received results during ANC in the Figure 1 approximates the 28% reported in the 2013 NDHS. The slight difference could be as a result of the study sample restriction to only birth from 2011-2013 as against 2008-2013 used in the 2013 NDHS report.

Study variables

Measures of outcome variable

The dependent variable for this study is the utilization of ANC-HIV testing among pregnant women in Nigeria. In the 2013 NDHS, pregnant women who attended ANC for the most recent birth and were offered HIV test responded to these questions, I don't want to know the results, but (a) were you tested for AIDS virus during any of the antenatal visits? If yes, (b) did you get results of AIDS test? Women who answer 'yes' to these two questions are classified as having been tested for HIV during

ANC. Pregnant women who were not tested as part of ANC are those who responded 'no' to either of the two questions (Staveteig et al., 2013; NPC & ICF International, 2014). Women who were tested are coded '1' and those who were not tested are coded '0'' indicating a dichotomous response variable.

Measures of explanatory (PENS) variables

The independent variables in this study are the adapted Andersen PENS (i.e. predisposing, enabling, need and stigma) predictors of service use. Based on the theory, reviewed literature and data availability, the following variables were selected and thereby operationalized as shown in Table 1. It should be noted that few of the variables have been re-coded for the purpose of this study. These variables are polygyny, age at first sex and marital duration. For the original coding, refer to NDHS questionnaires (NPC & ICF International, 2014). However, the coding categories adopted in this research are in consistence with previous studies (Liu et al., 2007; Sambisa, 2008; Antai, 2009; Sarin et al, 2013; Lepine et al., 2014; Semali et al., 2014) except for the "home" category of the place of ANC visit which seems to be newly introduced in this study based on the information available in the 2013 NDHS. The operationalization of HIV risk behaviour and risk perception are selected carefully based on previous literature (Akwara et al., 2003; Lepine et al., 2014).

Although the 2013 NDHS contains information on observed enacted stigma, the variable is excluded from the analysis since it is only limited to the 2012-2013 year interval with a distantly lower number of observations – 3,622 - compared to the 5,164 for the period of 2011-2013 selected in this present study. The anticipated stigma and self-stigma variables are not available in the 2013 NDHS dataset. The two literature reviewed in this study which used the anticipated stigma adopted a primary data collection technique (Kilewo et al., 2001; Turan et al., 2011) rather than the secondary (NDHS) data used in this study. The pre-test HIV counselling variable was generated from a combination of three questions in the survey. Women were asked, as part of your ANC visits for your last birth, did anyone discuss with you about (1) mother to child transmission of HIV (2) how to prevent getting HIV and (3) HIV testing. Binary variable of pre-test ANC-HIV counselling was generated , being "1" if answered "yes" to any of the these questions and "0"otherwise.

Consistent with other studies (Liu et al., 2007; Liu & Becker, 2008; Sambisa, 2008), variables like HIV knowledge, bargaining power, intimate partner violence and HIV stigma in this study were constructed from a set of correlated indicators using the principal component analysis (PCA) with varimax rotation. This technique was used to obtain the household wealth quintile in most DHS including the 2013 NDHS (NPC & ICF International, 2014). The PCA is a statistical tool which is used to condense the number of variable dimensions without significant loss of relevant information. Details about the combined indicators used to generate each of the variables including their measures of internal consistencies and validity, which are acceptable, are attached as appendices A, B, C and D. It should however be noted that, while constructing the AIDS stigma index**,** question on *whether the respondent support that HIV infection in a family should remain secret* was excluded from the index due to its relatively low squared multiple correlation (SMC) - result not shown - with all other indicators included. Also, in the case of HIV knowledge index, question on *whether abstinence is a way of reducing risk of getting HIV* was not included due to its absence from the 2013 dataset, compared to the previous survey. Similar cases of omission were also observed when generating index of bargaining power score such as variables on final say on what food to cook as well as on making household purchases daily.

Asides from place of residence and place of ANC attendance during pregnancy, all other contextual model variables were newly generated and/or added to the dataset. For instance, at the community level, these variables are community poverty level and community women's education which are both categorized as parts of the enabling factors. They were constructed based on household wealth index and level of education as reported by the women in the cluster. Like in Antai (2009) and Lepine et al. (2014), the clusters which represent the primary sampling units in the dataset were used as proxies for "communities" in the computation and modelling. At the state level, information the variable on HIV state prevalence was obtained from the 2012 NARHS report as earlier explained.

Statistical analysis

Methodology

A multilevel analysis model was modelled in order to account for the contextual nature of the Andersen behavioural model (Philips et al. 1998; Babitsch et al., 2011) and the hierarchical or complex structure of the DHS data (Akwara et al., 2003; Antai, 2009; Lepine et al., 2014). In the 2013 NDHS, individuals (level 1) were nested within clusters/communities (level 2), which were in turn nested within their respective states (level 3). Besides, the Nigerian health sector is characterised by disproportionate differences in quality of service deliveries and resources across regions (NPC & ICF International, 2014). Thereby, considering the high decentralised system of government in the country, the tendencies of unequal level of commitment towards various health programmes and policies across all levels cannot be overlooked. As noted by Lepine et al. (2014) in a study among the Nigerian couples, HIV testing utilization may be influenced differently by unobserved community- and state-level heterogeneities in Nigeria. Furthermore, the ethnic cum cultural diversities which spread across different communities within most states in Nigeria, do not only mirror the sociocultural identities but also differences in attitudes as well as health-seeking behaviours among others (Antai, 2009). Therefore, the observations from the same community and/or state may not be assumed to be mutually independent, which thereby violate the assumption of independence of observations upon which ordinary logistic regressions are based. This study thereby adopted a three-level multilevel modelling function similar to that of Lepine et al. (2014). The model comprises of fixed effects - measures of association - and random effects - measures of variation - in a single equation (mixed effects). This mathematical model has however been modified to address the aim of this research using the (adapted) Andersen model PENS variables and is as written as follows:

$$Logit\{Pr(V_{iphjk}=1|PENS_{iphjk},\zeta^{(2)},\zeta^{(3)})\}=\beta_1+\beta_2 PENS_{2iphjk}+\ldots+\beta_n PENS_{nk}+\zeta_{jk}^{(2)}+\zeta_k^{(3)}$$

Where $PENS_{2iphjk}+\ldots\ldots+PENS_{nk}$ represent a range of independent variables - predisposing (P), enabling (E), need (N) and stigma(S) - of the woman *i*, of her partner *p*, of her household *h*, residing in community *j* which is lodged in state *k*. The $\zeta_{jk}^{(2)}$ and $\zeta_k^{(3)}$ represent the random effect terms at the community (level 2) and state (level 3) respectively, which in turn indicates unobserved heterogeneous PENS characteristics at both the community- and state- levels.

Model building strategy

A total of five models were estimated. The first model (*model 0*) is an intercept-only model – a variance component model- comprising no covariates. This model helps to show if there are sufficient variance at higher levels and how the total variance is decomposed into community and state components. All the individual variables were added simultaneously in *model 1*. The individual-level variables in the analysis include all the household-level variables. Since the average number of eligible women in every household is 1.47 (result not shown), the household could not therefore be regarded as another level of analysis. In *model 2*, all the community-level variables were added and adjusted for. The state-level variable was then included in *model 3*, the final model. A purposeful variable selection - a step-by-step approach- as illustrated by Hosmer et al. (2013) was used during the model building. Compared to other traditional methods such as stepwise, the approach allows the researcher to be responsible for the critical model evaluation rather than solely relying on traditional statistical benchmark of p=0.25 (Hosmer et al., 2013). Thus, this variable inclusion procedure allows for a theory-driven variable selection and helps to reduce endogeneity due to omitted variable bias.

A multi-collinearity test was carried out using variance inflation factors (VIF) approach. The squared term of the women's age was excluded from the VIF analysis. The VIF results show the highest VIF as 2.96 and the mean VIFs as 1.60. These do not show evidence of multi-collinearity. However, some variables could not pass the (multi) collinearity test and were therefore dropped in order to arrive at the best possible model estimates. This includes dropping of region and ethnicity for religion, children ever born for marital duration, occupation for education as well as MTCT knowledge for pre-test HIV counselling (which contains information on MTCT). The choice of all the selected final variables is based on the observed statistical and/or clinical relevance in the past studies. Generally, cases of

missing data for the selected NDHS variables in this study are very scanty and low, where exist. All the missing data were treated using a complete-case-analysis approach.

All the fixed effects are expressed as crude odds ratio (OR) in the univariate (unadjusted) models and adjusted odds ratio (AOR) in the multivariate (adjusted) models. A 95% confidence intervals was used (95% CI). The random effects are expressed as variance partition coefficient (VPC) – otherwise known as intra-class correlation coefficient (ICC) - and proportional change in variance (PCV). The estimates of the variance partition coefficient (VPC) is decomposed into intra-state and intra-community correlation coefficients. The adaptive Gaussian quadrature (AGQ), which is available in Stata by default via *xtmelogit*, is used to estimate the log-likelihood (Gutierrez, 2007). The Likelihood ratio (LR) statistic is used to examine the significance levels of the random effects and their precision level are appraised by the standard error (SE). The multilevel model fitness is tested using deviance information criterion (DIC). All analyses, including the PCA, are performed using Stata statistical software (version 13).

Ethical considerations

Secondary data, mainly the 2013 NDHS, was used for the data analysis. The DHS had already taken ethical issues into consideration such as the assurance of voluntary participation of respondents, anonymity and confidentiality. The ethical permission for the use of the data in this research was obtained from ICF Macro Inc., USA.

Results

Descriptive statistics

The descriptive statistics of the outcome variable and all the selected independent (PENS) variables are shown in Table 2. As mentioned earlier, the analysis covered a total of 5,164 sampled women in this study. However, due to few cases of missing data (where exist), the sample size varies slightly across the PENS variables. The data shows that approximately 75% of the 5,164 pregnant women received the ANC-HIV test, indicating that about 1,291 (25%) of the total sampled pregnant women declined the test and perhaps delivered without knowing their HIV status. The percent of ANC-HIV testing uptake (75% of 5,164) shown in Table 2 corresponds to the about 27% of the total 14,220 women who gave births two years prior to 2013 earlier described in Figure 1. Also, as summarized in Figure 1, estimates of ANC coverage between 2011-2013 and ANC-HIV test availability - for those attended ANC – are about 66% (of the 14,220 women) and 55% (of those who attended ANC) respectively. The descriptive summary of all the PENS variables are presented in Table 2. Also, the descriptive results of the relationship between HIV prevalence and ANC-HIV testing prevalence per state are mapped out in Figures 2 and 3. As depicted in the figures, uptake of ANC-HIV testing is high in most of the Nigerian states where HIV prevalence is high, an indicative of a positive association which corresponds to the results of the logistic models in Tables 3 and Table 4.

Multilevel logistic regression analysis

The crude association between the PENS factors and the outcome variables are examined at bivariate level of analysis (see Table 3). In the table, it can be observed that three variables – namely the intimate partner's violence, multiple sexual partnering and history of STIs - have p-values which are all higher than 0.25 and should not ordinarily be considered for multivariate analysis. However, statistical and theoretical evaluations showed that these variables are very important and attempt to omit them from the multivariate analysis would bias the model estimates, thus making their inclusion necessary. The multivariate analysis (Table 4) indicates that the associated total variances in the utilization of ANC-HIV testing with higher level contexts examined in this study were estimated from the Model 0, an empty model with no covariates. This estimate helped to partition the total variance into community-level and state-level variances which in turn produced the intra-class correlation coefficients (ICC), otherwise known as variance partition coefficients (VPC) for the two levels. The

variation in the uptake of ANC-HIV testing across communities ($\tau = 0.69$, $p<0.001$) and states ($\tau = 0.79$, $p<0.001$) were both significant. Based on the estimated variance partition coefficient, the intra-community and intra-state correlations were 31% and 17% respectively. These indicate the extent of variability in the utilization of ANC-HIV testing represented at community and state levels respectively.

All the individual and household level variables were included into Model 1 (see Table 4). Among the predisposing variables included, religion and HIV knowledge were found to be significantly associated with the outcome variable. For instance, the result in model 1 shows that women who practised traditional religion had 77% lower likelihood of been tested for HIV during ANC visit (AOR = 0.23, 95% CI = 0.06-0.87) compared to the Catholic women. Likewise, women with higher HIV knowledge were more likely to be tested for ANC-HIV as a unit increase in HIV knowledge score increased the odds of being tested by 9% points (AOR = 1.09, 95% CI = 1.01-1.18). Also, among the enabling factors, ANC-HIV testing uptake was significantly related to household wealth, household bargaining power and partner's education. A unit increase in the score of household wealth index increased the likelihood of using ANC-HIV testing by over 40% points (AOR = 1.43, 95% CI = 1.19-1.70). After controlling for intimate partner's violence, an increase in the bargaining power score of women increased the ANC-HIV testing uptake by 9% points (AOR = 1.09, 95% CI = 1.01-1.17).

Also in Model 1, the likelihood of ANC-HIV testing uptake was found to be 52% higher among women whose partner had primary education (AOR = 1.52, 95% CI = 1.00-2.31), 63% higher for secondary education (AOR = 1.63, 95% CI = 1.09-2.44), and 70% higher for tertiary education (AOR = 1.70, 95% CI = 1.09-2.67) compared to women whose partners had no education. Further, women who received pre-test HIV counselling during ANC visit were found to have slightly more than two times higher odds of being tested for ANC-HIV (AOR = 2.25, 95% CI = 1.71-2.95), compared to those who were not counselled. Among all the need factors introduced in Model 1, knowing someone with AIDS was found to be significantly associated with uptake of ANC-HIV testing. The odds of being tested for HIV during ANC visit was 40% higher for women who knew someone living with AIDS (AOR = 1.40, 95% CI = 1.00-2.31), compared to women without any knowledge.

When other (individual) variables were controlled for in model 1, HIV stigma towards PLWH/A showed no significant association with uptake of ANC-HIV testing (AOR = 1.03 95% CI = 0.95-1.10). We made efforts to identify the key control variables of the stigma effect in the multivariate model using a guideline suggested by Rothman & Greenland (1998). Implicitly, the guideline states that a variable has to be associated with ANC-HIV testing uptake ($p<0.10$), with stigma variable ($p<0.10$) and must have more than 10% effect change on the association. Such control variable can be regarded as meditating if it is positioned with the causal chain or as confounding if it is found outside the causal chain. The third category is classified as having modifying effects if it neither lays within nor outside the causal chain but changes the association by more than 10%. The result (Table 5) shows that variables like women's education, household wealth, HIV knowledge and pre-test HIV counselling significantly modified the independent effect of HIV stigma on ANC-HIV testing in the model.

In comparison to Model 0 (the empty model), the variation in the utilization of ANC-HIV testing remained significant across communities ($\tau = 0.72$, $p<0.001$) and states ($\tau = 1.02$, $p<0.001$). The variances of the community- and state-level factors in Model 1 were both higher than those in Model 0, which shows that the inclusion of individual-level variables reinforced both the community and state variances. The proportional change in variances (PCVs) in the odds of ANC-HIV testing uptake of 4% across communities and 29% across states were explained by individual-level characteristics. This shows that the composition of individual characteristics explained part of the nesting of ANC-HIV testing uptake within communities and states. The intra-community and intra-state variances were 34.6% and 20.2% respectively.

Similar patterns of results for odds of ANC-HIV testing uptake obtained in Model 1 - as discussed above - were also observed in model 2. All the enabling community-level variables were controlled for in Model 2. The model result indicates that the odds of utilizing ANC-HIV testing was approximately 50% lower for women who received antenatal care at their homes or other homes for their last birth (AOR = 0.48, 95% CI = 0.25-0.91), compared to those who received antenatal care at government health care facilities. Compared to Model 1, the variation in utilization of ANC-HIV testing remained significant across communities ($\tau = 0.69$, $p<0.001$) and states ($\tau = 1.02$, $p<0.001$). The inclusion of the community level variables only reduced the variance across community from 0.72 to 0.69 ($p<0.001$), leaving the state variance constant. The PCVs of the likelihood of ANC-HIV testing uptake of 34% across communities and approximately 0% across states were explained by the community-level factors, indicating that part of the nesting of ANC-HIV testing within areas was associated with only the community composition by community-level factors. The intra-community and intra-state variances were 34.3% and 20.5% respectively.

In Model 3, a state level variable - HIV prevalence - was introduced and having controlled for all other PENS variables in the model, it remained significantly related to the use of ANC-HIV testing. The outputted fixed effects from Model 3 are approximately the same with the previous models (1 and 2) except for the variable measuring women bargaining power whose p-value increased to 0.05 (CI= 0.99-1.16) thereby making it to be statistically marginally significant at 5% level. The model also indicates that the likelihood of receiving ANC-HIV testing was higher in states with higher HIV prevalence (AOR = 1.13, 95% CI = 1.02-1.25). Compared to Model 2, the intra-community variance remained appropriately the same and significant ($\tau = 0.69$, $p<0.001$). However, the inclusion of the state level variable reduced the state level variance from 1.02 ($p<0.001$) in Model 2 to 0.88 ($p<0.001$) in Model 3 and also remained significant. Interestingly, this indicates that the addition of the state-level variable only reduced the state variance over the previous model (from 1.02 to 0.88, $p<0.001$). About 0% and 14% of the PCVs across communities and states were due to state HIV prevalence. This suggests that, to an extent, part of the nesting of the utilization of ANC-HIV testing could be attributable to differences in HIV prevalence rates by states. The intra-class correlation coefficients in the model 3 were 32.4% and 18.1% across communities and states respectively.

In all the five estimated multivariate models in Table 3, intra-community correlation coefficients were always higher than the intra-state correlation coefficients, indicating that observations from women from the same community were more homogeneous than those from the same state. The **s**uccessive reduction in Deviance Information Criterion (DIC) from Model 0-3 demonstrates a better fit model over every previous one in Table 3. The lowest deviance for Model 3 compared to the three previous models indicated that the model fitted the most.

Discussion

The 75% in ANC-HIV testing prevalence found in this study should not be directly compared with the 28% ANC-HIV prevalence estimated in the 2013 NDHS final report (NPC & ICF International, 2014). This is because the denominator which produced the NDHS report estimate includes women who did not attend ANC while pregnant rather than the sampling criteria employed in this study which excludes those who did not attend ANC or attended but not offered the HIV testing. Since the third-quarters of the pregnant women who met the present study sample were tested for HIV, compared to the slightly more than one-quarter among the general pregnant women population (regardless of whether they received ANC or not), concerted efforts are therefore required to scale up ANC attendance (which is found to be 65% in this study) as well as availability of ANC-HIV testing (which is only 55% of the total number of the ANC attendants) as they both clearly serve as prerequisites for the utilization of the service. This observation is consistent with earlier findings by Larsson et al. (2009).

The results from the multilevel analysis show that the utilization of ANC-HIV testing was clustered within communities as well as within states and as one would have expected, the observations from women from the same community were more homogeneous than those from the same state. This is

not unexpected due to the high ethno-cultural diversities in Nigeria which, to a large extent, serve as markers of cultural and attitudinal identities, socio-economic status and health beliefs (Antai, 2009). After controlling for the unobserved community- and state-level heterogeneities as well as other theoretically and/or statistically relevant PENS variables selected for the multivariate analysis, the study findings show that the enabling factors were the most dominant predictors of uptake of ANC-HIV testing in Nigeria. This could be expected since, according to Andersen (1995), the use of healthcare services which are considered to be highly optional or at will (like the uptake of ANC-HIV testing which is voluntary) is likely to be explained more by the enabling factors as well as social and health beliefs characteristics. Five enabling factors (household wealth, bargaining power, partner's level of education, pre-test HIV testing and place of ANC visit) were found to be associated with ANC-HIV testing in Nigeria.

Consistent with the previous studies (Semali et al., 2014; Lepine et al., 2014), the results indicate a positive linear relationship between household wealth and ANC-HIV testing uptake. One possible explanation is that, since higher household wealth could be indicative of higher number of educated household members, women from such household would have higher likelihood of making sound healthcare decision (Kalule-Sabiti et al., 2014; Semali et al., 2014). Though the ANC-HIV test is free in Nigeria, wealthy household could have increased access to healthcare including the ease of transportation to the testing centres (Semali et al., 2014; Lepine et al., 2014) and in this case, the ANC-HIV testing clinics. Women's bargaining power in the household was also found to be marginally positively associated with the uptake of ANC-HIV testing. This finding supports another study among Nigerian married women which also revealed marginal effect of women's bargaining power on HIV testing utilization- though not necessarily among the pregnant women attending ANC -(Lepine et al., 2014). In line with another finding by Semali et al. (2014), this study found strong association between uptake of pre-test ANC-HIV counselling and uptake of ANC-HIV testing as pregnant women attending ANC who received the comprehensive HIV counselling were found to be more than twice likely to be tested compared to their counterparts who did not receive the HIV counselling. The pre-test HIV counselling which included information of MTCT in the 2013 NDHS could be argued to enable the antenatal attendants to have improved knowledge of how to prevent MTCT and hence the ANC-HIV testing uptake.

However, incongruent with other studies (Bajunirwe & Muzoora, 2005; Ayiga et al., 2013; Semali et al., 2014), the woman's level of education was not associated with use of ANC-HIV testing but rather the education level of their male partners. This could be as a result of the highly multivariable analysis adopted in this study as against the lack of control for partner's education by Ayiga et al. (2013) and Semali et al. (2014), and bivariate analysis used by Bajunirwe & Muzoora (2005). Intuitively, this result is expected since on the average, Nigerian men are more educated than their women (Lepine et al., 2014). The effects of women's education status particularly in a largely polygamous country like Nigeria could be expected to be taken over by that of their partners. Also, despite the facts that only small proportion (about 2%) of the study sample received antenatal care and ANC-HIV testing offers at their homes or other homes, the results showed that the ANC-HIV testing uptake was generally low among this subgroup compared to their counterparts who received the ANC at government-owned clinics or hospitals. This study seems to be the first to establish this relationship. According to Andersen (1995), enabling factors are usually highly mutable for short-term policies. This points to the advantage of the dominant influence of the enabling factors over the predisposing, need and stigma factors on the use of ANC-HIV testing in this study.

Among the predisposing factors, both religion and HIV knowledge were associated with ANC-HIV testing uptake. Previous literature has indicated common attribution of illness among traditional religion followers to divine affliction, witchcraft, anger of the ancestors, affliction from sorcerers and infringement on taboos (Aguwa, 2010). This explains the present findings which showed low uptake of ANC-HIV testing among pregnant women attending ANC who practised traditional religion compared to the catholic women. Similar findings have been previously documented in Nigeria (Lepine et al., 2014) and Zimbabwe (Sambisa, 2008). Also consistent with the previous study by Lepine et al. (2014), positive relationship was indicated between HIV knowledge score and the

likelihood of taking the ANC-HIV test. This pattern of relationship is not surprising as HIV knowledge is generally high among antenatal attendants in Nigeria (Igwegbe et al., 2005).

Furthermore, HIV risk perception, operationalized as knowing someone living with AIDS and state HIV prevalence, served as the need factor for ANC-HIV testing uptake. Similar to this finding, HIV testing utilization among Nigerian married women in general has been previously associated with knowing someone living with AIDS (Lepine et al., 2014) which suggests that having close acquaintance with HIV/AIDS may necessitate taking necessary behavioural change to avoid it (Magadi and Desta, 2011). Similar to earlier observations by Magadi and Desta (2011), the positive association between the state HIV prevalence and antenatal HIV testing use may be an indication of higher awareness of HIV/AIDS and subsequent acceptance of HIV testing in states with high prevalence rate which may require intensive efforts to combat HIV-related stigma issues in low prevalence states.

The negative impacts of HIV-related stigma on HIV testing uptake have been documented in the literature (Sambisa, 2008; Ayiga et al., 2013; Lepine et al., 2014). However, findings showing association between HIV stigmatizing attitudes towards PLWH/A (one of the HIV stigma measures) and HIV testing use among pregnant women attending ANC is scanty. The attempt in this present study revealed no significant association between these two variables. This finding is somewhat similar to previous finding in Tanzania by Semali et al. (2014), where the effect of the stigmatising attitude only approached but could not quite reach the traditional significance level criterion of 0.05 (AOR=1.29, p=0.103). In contrast, when anticipated stigma from male partner (another HIV stigma measure) was used as an indicator of HIV stigma, Turan et al. (2011) documented its strong negative effects on the use of ANC-HIV testing among the pregnant women attending ANC, after adjusting for other individual variables. Turan et al. (2011) explained that since the pregnant woman is usually the first to be tested for HIV in a family which is perhaps through the provider-initiated testing and counselling (PITC) in health facilities, she may be afraid of suffering from severe negative consequences from her male partner after the disclosure of her new HIV status, if tested positive. This association could not be examined in this present study due to lack of information on the anticipated stigma from male partner in the secondary data used.

However, since the effect of having stigmatizing attitudes towards PLWH/A on ANC-HIV testing uptake was strong in the unadjusted model of the present study, effort was made to identify the potential effect modifier(s) between the two variables. Using the guideline proposed by Rothman & Greenland (1998), four variables are identified as important effect modifiers of the independent association between HIV stigma and ANC-HIV testing uptake observed earlier in the unadjusted model. These variables are HIV knowledge, household wealth, pre-test HIV counselling and women's level of education. Of all the identified variables (potential effect modifiers), only the women's level of education was controlled for by Semali et al. (2014) and thus the possible reason for the observed marginal effect of the stigmatising attitude on the uptake of ANC-HIV testing in their study. The present study findings can be possibly explained by the earlier suggestion by Ow & Lee (2012) that externalization and group identification have potential effect on Stigma. Inferably, this could indicate that the pregnant women who are educated, more knowledgeable about HIV/AIDS or come from wealthy family and/or who go out for ANC and received HIV counselling (which includes information on MTCT), are likely to have reduced or insignificant effect of stigmatising attitudes towards PLWH/A on their uptake of ANC-HIV testing in Nigeria.

Limitations of the study findings

The study empirical findings are not without some limitations, most of which are largely due to either the nature of the variables used or their complete absence from the dataset. Firstly, the 2013 NDHS (women data) only contained information on individual woman's stigmatising attitude and observed enacted stigma towards PLWH/A. However, the available information on the former is only limited to 2012-2013 period with a significantly lower number of observations compared to the period of 2011-2013 selected in this present study. The absence of information on the other dimensions of

HIV stigma especially the anticipated stigma from partner in the dataset enervates the study efforts to support the importance of this key barrier variable - HIV stigma - in the adapted model (AABM) for the ANC-HIV testing in this present study. Secondly, the 2013 NDHS did not include information on the HIV status of the women which has been suggested to have potential impact of some of the model variables like the HIV knowledge and stigma (Lepine et al., 2014). Similar cases of absence of variables from the dataset were observed for variables like ever use of condom, prior HIV testing, knowing whether partner has been tested or not, non-sex related HIV risk behaviour, and intended future use of ANC-HIV testing. The information available on the history of STIs, though it is limited to 2012-2013 year interval rather than the 2011-2013 covered in this study, STIs variable was however included in the analysis after a sensitivity test was run and yielded no conspicuous difference. Likewise, absence of direct variable measuring HIV risk perception prompted the use of its proxy measures. However, the proxy measures may not always produce findings similar to those outputted by direct measure. Likewise, the cross-sectional data limited the study evidence of causal relationship between the PENS predictors and the response variable. Furthermore, there could have been cases of misreporting of HIV testing due to recall errors. Besides, since the data is self-reported, some of the information could have been underreported particularly on sensitive information such risky sexual behaviour. Last but not the least, this study is also limited by paucity of contextual variables and thereby limits the potential of the multilevel analysis in examining the influence of contexts on individual health seeking behaviour (Magadi & Desta, 2011).

Conclusion

This study is the first attempt to examine the determinants of ANC-HIV testing utilization in Nigeria using a nationally representative data and as well the first to apply the Andersen behavioural model to this ANC-HIV testing. Based on the (adapted) Andersen behavioural model, the study aimed to examine predisposing, enabling, need and HIV-stigma (PENS) factors associated with uptake of ANC-HIV testing among pregnant women in Nigeria. The findings reveal that the enabling factors dominate the influencing factors of ANC-HIV testing use and accounted for more variations in the outcome measure over and above the other PENS variables. These are largely mutable factors for short-term policies and should be given priority in attaining the future policy actions such as the United Nations' 90-90-90 targets by 2020 and 95-95-95 targets by 2030. Likewise, full and equitable access to antenatal care and HIV testing during the ANC visits are suggested as prerequisites to increasing the ANC-HIV testing coverage. The findings also signal that policies intervention programmes aimed at scaling-up the uptake of antenatal HIV testing should focus not only on individual-level characteristics but also on the community- and state-levels differences especially in an ethnically diverse and administratively decentralized government structure like Nigeria.

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Figures

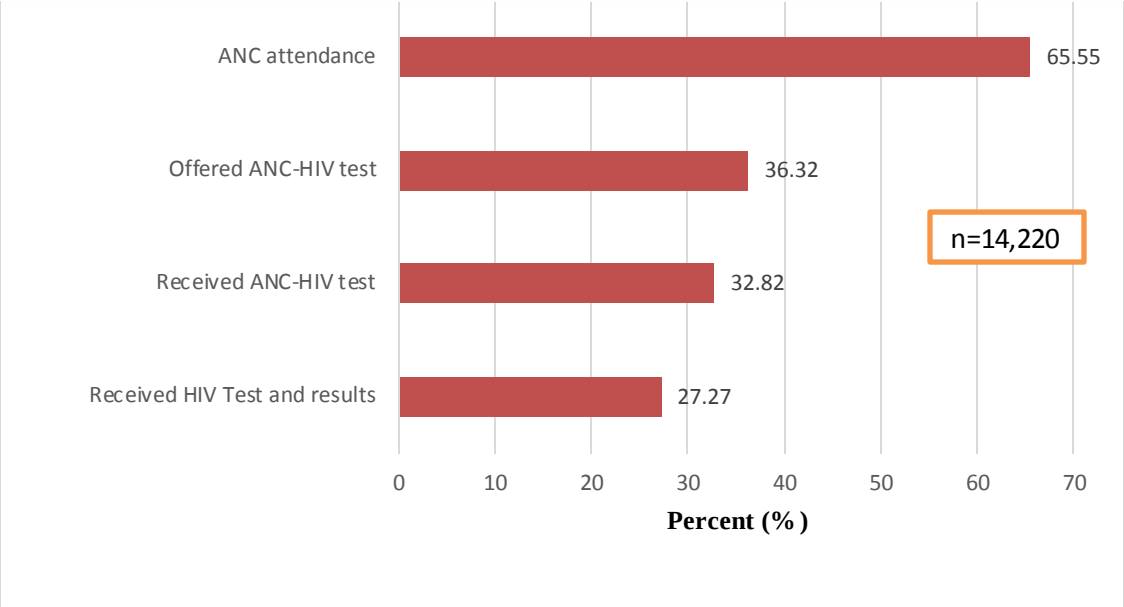

Figure 1: Estimates of ANC-HIV test uptake components by 14,220 Nigerian women who gave birth between 2011-2013
Data source: 2013 NDHS

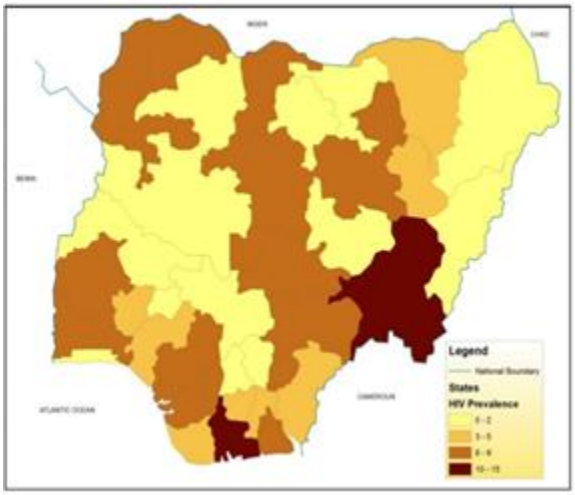

Figure 2: HIV prevalence (%) per state

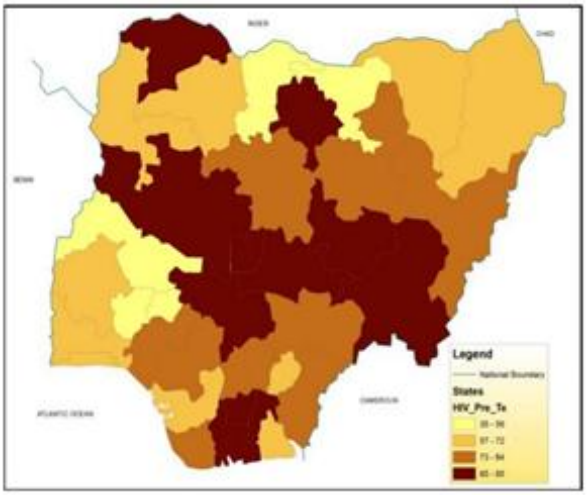

Figure 3: ANC-HIV testing prevalence (%) per state

Tables

Table 1 Operational definitions of selected PENS variables

Variable	Operational definition and measurement
Predisposing variables	
Age	Current age in single completed years (self-reported) at the time of survey
Religion	Religious affiliation: Catholic, Other Christian, Muslim, Traditionalist
Women education	Highest educational level attained: none, primary, secondary, higher
HIV knowledge[a]	HIV knowledge index: factor score
Enabling variables	
Wealth	Household wealth index: factor score
Bargaining power[a]	Bargaining power index: factor score
Intimate partner violence[a]	Index of intimate partner violence: factor score
Polygyny	Number of other wives by partner: none, at least one
Partner's education	Partner's highest level of educational attained: none, primary, secondary, higher
Health insurance	Covered by of health insurance: no, yes
Pre-test ANC-HIV counselling	Received HIV test counselling as part of antenatal care (ANC): no, yes
Residence[b]	Place of residence: Urban, rural
Place of ANC[b]	Place of ANC visit during pregnancy: government owned, private owned, home
Community poverty[b]	Average household wealth index in the community: high, middle, low
Community education[b]	Average level of women's education in the community: low, middle, high
Need factors (Risk behaviour)	
Number of lifetime sexual partner	Number of lifetime sex partners a woman has had: numeric
Age at first sex	Age at first sexual intercourse: Classified as <15, 15-19, 20+ (in years)
History of STIs[c]	History of STIs in the last 12 months preceding the survey: no or yes
Need factors (Risk perception)	
Knows someone with AIDS	Knowledge of someone who has or is suspected to have the AIDS virus: no, yes
Marital duration	Length of marriage in : 0-4, 5-9, 10-14, 15+ (in years)
State HIV prevalence[d]	HIV prevalence rate in the state of residence of a woman : continuous
Stigma variable	
Stigmatising attitude towards PLWH/A[a]	Factor score of stigmatising attitude against PLWH/A index

[a]Variables generated through principal component analysis in this study, [b]Community-level variables

[c] STIs= sexually transmitted infections, [d] State-level variable

Table 2 Descriptive statistics of response and outcome variables

Variables	Obs.	Mean	SD	Min.	Max.
Tested for HIV	5164	0.751	0.432	0	1
Predisposing factors					
Age	5164	29.039	6.399	15	49
Age squared	5164	884.182	389.717	225	2401
Religion: Catholic	5142	0.144	0.351	0	1
Religion: Other Christian	5142	0.476	0.499	0	1
Religion: Islam	5142	0.377	0.485	0	1
Religion: Others	5142	0.004	0.059	0	1
Education: None	5164	0.156	0.363	0	1
Education: Primary	5164	0.201	0.401	0	1
Education: Secondary	5164	0.482	0.499	0	1
Education: Tertiary	5164	0.161	0.367	0	1
HIV knowledge	4617	0.000	1.283	-5.418	1.196
Enabling factors					
Wealth	5164	0.438	0.906	-2.121	2.678
Health insurance	5155	0.040	0.195	0	1
Bargaining power	4731	0.000	1.517	-1.873	4.534
Intimate partner's violence	4,112	0.051	1.853	0.619	17.314
Polygyny					
Partner's education: None	4962	0.114	0.318	0	1
Partner's education: Primary	4962	0.182	0.386	0	1
Partner's education: Secondary	4962	0.439	0.496	0	1
Partner's education: Tertiary	4962	0.265	0.442	0	1
Pre-test HIV counselling	5164	0.821	0.383	0	1
Place of ANC: Government owned	5103	0.730	0.444	0	1
Place of ANC: Private owned	5103	0.254	0.436	0	1
Place of ANC: Home	5103	0.016	0.125	0	1
Rural residence	5164	0.426	0.496	0	1
Community education: Low	5164	0.148	0.355	0	1
Community education: Middle	5164	0.378	0.485	0	1
Community education: High	5164	0.474	0.499	0	1
Community poverty: Low	5164	0.160	0.367	0	1
Community poverty: Middle	5164	0.348	0.476	0	1
Community poverty: High	5164	0.492	0.499	0	1
Need factors (Risk behaviour)					
Number of lifetime sexual partner	5151	1.649	1.09	1	20
Age at first sex: <15	5157	0.117	0.322	0	1
Age at first sex:15-19	5157	0.518	0.499	0	1
Age at first sex: 20 & above	5157	0.365	0.481	0	1
History of STI	5091	0.039	0.194	0	1
Need factors (Risk perception)					
Knows someone with aids	5119	0.201	0.401	0	1
Marital duration: 0-4years	4982	0.325	0.468	0	1

Table 2 continued

Variables	Obs.	Mean	SD	Min.	Max.
Marital duration: 10-14years	4982	0.186	0.389	0	1
Marital duration: 15years plus	4982	0.208	0.406	0	1
State HIV prevalence	5164	3.434	3.219	0.2	15.2
Stigma factor					
HIV stigma towards PLWH/A	5148	0.000	1.484	-1.666	3.033

SD: Standard Deviation, N=5,164
Data source: 2013 NDHS

Table 3 Result of bivariate logistic regression analysis of ANC-HIV testing uptake

variable	OR	95% CI	p-value
Predisposing factors			
Age	1.17***	1.07-1.28	0.000
Age squared	0.99***	0.98-1.00	0.000
Religion: Other Christian (RC: Catholic)	0.81	0.61-1.06	0.127
Religion: Muslim	0.65**	0.47-0.91	0.012
Religion: Traditionalist	0.24**	0.08-0.71	0.010
Education: Primary (RC: None)	1.00	0.85-1.43	0.467
Education: Secondary	1.57***	1.22-2.02	0.000
Education: Tertiary	2.71***	1.98-3.71	0.000
HIV knowledge	1.23***	1.15-1.30	0.000
Enabling factors			
Household wealth	1.79***	1.59-2.01	0.000
Health insurance	2.07***	1.31-3.29	0.002
Bargaining power	1.09***	1.02-1.15	0.006
Intimate partner's violence	0.99	0.94-1.03	0.534
Polygyny	0.82*	0.67-1.01	0.057
Partner's education: Primary (RC:None)	1.59***	1.18-2.14	0.002
Partner's education: Secondary	2.07***	1.57-2.72	0.000
Partner's education: Tertiary	3.01***	2.24-4.03	0.000
Pre-test HIV counselling	2.33***	1.93-2.82	0.000
Place of ANC: Private owned (Govt. owned)	1.10	0.91-1.34	0.337
Place of ANC: Home	0.48***	0.28-0.81	0.007
Rural residence	0.63***	0.51-0.79	0.000
Community education: Middle (RC:Low)	1.22	0.89-1.67	0.012
Community education: High	1.73***	1.25-2.42	0.000
Community poverty: Middle (RC:High)	1.33*	0.99-1.78	0.053
Community poverty: Low	1.69***	1.25-2.29	0.001
Need factors (Risk behaviour)			
Number of lifetime sexual partner	1.02	0.95-1.09	0.621
Age at first sex: 15-19 (RC: <15)	1.20	0.95-1.52	0.127
Age at first sex: 20 & above	1.37**	1.06-1.77	0.015
Resent history of STI	1.11	0.73-1.68	0.621
Need factors (Risk perception)			
Knows someone with aids	1.43***	1.15-1.79	0.002
Marital duration: 5-9years (RC: 0-4years)	1.11	0.28-92	0.284
Marital duration: 10-14years	0.87	0.69-1.08	0.210
Marital duration: 15years plus	0.76**	0.62-0.94	0.011
State HIV prevalence	1.13***	1.04-1.23	0.004
Stigma factor			
HIV/AID stigma	0.91***	0.86-0.95	0.000

Data source: 2013 NDHS

Table 4 Results of multivariable multilevel mixed-effect modelling of ANC-HIV testing uptake in Nigeria

Variable	Model 0		Model 1		Model 2		Model 3		Model 4	
	Empty model		Individual variables		Community variables		State variable		Interaction variables	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Fixed effects										
Constant	3.84	2.82-5.23	0.93	0.11-7.84	1.26	0.14-11.20	0.85	0.09-7.73	**0.82**	**0.09-7.55**
Predisposing factors										
Age			1.03	0.89-1.189	1.02	0.89-1.17	1.02	0.89-1.18	1.03	0.89-1.18
Age squared			0.99	0.99-1.00	0.99	0.99-1.00	0.99	0.99-1.00	0.99	0.99-1.00
Religion: Other Christian (RC: Catholic)			0.84	0.59-1.19	0.84	0.59-1.19	0.83	0.59-1.19	0.85	0.59-1.21
Religion: Muslim			0.79	0.52-1.22	0.82	0.53-1.27	0.83	0.53-1.27	0.85	0.55-1.31
Religion: Traditionalist			0.23*	0.06-0.87	0.23*	0.06-0.86	0.22*	0.06-0.84	0.22*	0.06-0.83
Education: Primary (RC: None)			0.82	0.56-1.20	0.81	0.55-1.20	0.81	0.55-1.19	0.81	0.54-1.19
Education: Secondary			0.99	0.67-1.47	0.97	0.65-1.46	0.97	0.65-1.46	0.97	0.65-1.46
Education: Tertiary			1.17	0.71-1.93	1.13	0.68-1.88	1.13	0.68-1.88	1.06	0.63-1.78
HIV knowledge			1.09*	1.01-1.18	1.09*	1.01-1.18	1.09*	1.01-1.18	1.11*	1.02-1.20
Enabling factors										
Household wealth			1.43***	1.19-1.70	1.48***	1.21-1.81	1.47***	1.21-1.81	1.47***	1.20-1.80
Health insurance			1.54	0.85-2.75	1.50	0.83-2.69	1.50	0.83-2.69	1.45	0.81-2.60
Bargaining power			1.09*	1.01-1.17	1.08*	1.00-1.16	1.07+	0.99-1.16	1.08+	1.00-1.16
Intimate partner's violence			1.00	0.95-1.06	1.00	0.95-1.06	1.00	0.95-1.06	1.01	0.95-1.06
Polygyny			1.09	0.82-1.46	1.12	0.84-1.50	1.13	0.84-1.51	1.12	0.84-1.50
Partner's education: Primary (RC: None)			1.52*	1.00-2.31	1.61*	1.05-2.45	1.61*	1.05-2.45	1.58*	1.04-2.42
Partner's education: Secondary			1.63*	1.09-2.44	1.73**	1.15-2.61	1.73**	1.15-2.60	1.71*	1.14-2.58
Partner's education: Tertiary			1.70*	1.09-2.67	1.77*	1.12-2.79	1.77**	1.12-2.78	1.75*	1.11-2.76
Pre-test HIV counselling			2.25***	1.71-2.95	2.24***	1.70-2.95	2.24***	1.71-2.96	2.21***	1.67-2.91
Place of ANC: Private owned (Govt. owned)					0.99	0.77-1.28	0.99	0.78-1.28	1.01	0.79-1.30

Table 4 continued

Variable	Model 0		Model 1		Model 2		Model 3		Model 4	
	Empty model		Individual variables		Community variables		State variable		Interaction variables	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Place of ANC: Home					0.48*	0.25-0.91	0.47*	0.25-0.91	0.48*	0.25-0.91
Rural residence					0.87	0.63-1.18	0.85	0.62-1.17	0.86	0.63-1.18
Community education: Middle (RC: Low)					1.11	0.71-1.74	1.09	0.69-1.71	1.08	0.69-1.69
Community education: High					1.27	0.71-2.26	1.23	0.69-2.21	1.22	0.69-2.18
Community poverty: Middle (RC: High)					0.71	0.47-1.07	0.70	0.46-1.06	0.71	0.47-1.07
Community poverty: Low					0.63	0.36-1.11	0.63	0.35-1.10	0.64	0.37-1.12
Need factors (Risk behaviour)										
Number of lifetime sexual partner			1.00	0.91-1.11	0.99	0.90-1.10	0.99	0.90-1.10	0.99	0.89-1.10
Age at first sex: 15-19 (RC: <15)			1.02	0.72-1.44	1.02	0.72-1.45	1.02	0.72-1.43	1.00	0.71-1.41
Age at first sex: 20 & above			0.98	0.97-1.47	0.96	0.64-1.45	0.96	0.64-1.44	0.96	0.63-1.45
History of STI			0.89	0.53-1.49	0.89	0.53-1.45	0.88	0.52-1.48	0.88	0.52-1.49
Need factors (Risk perception)										
Knows someone with aids			1.40*	1.03-1.89	1.44*	1.06-1.95	1.42*	1.05-1.93	1.42*	1.06-1.93
Marital duration: 5-9years (RC: 0-4years)			0.99	0.76-1.30	0.99	0.76-1.29	0.99	0.75-1.30	0.98	0.75-1.29
Marital duration: 10-14years			0.93	0.65-1.35	0.93	0.64-1.35	0.93	0.65-1.35	0.93	0.64-1.35
Marital duration: 15years plus			0.88	0.54-1.45	0.85	0.51-1.39	0.85	0.52-1.39	0.84	0.51-1.39
State HIV prevalence							1.13*	1.02-1.25	1.13*	1.02-1.25
Stigma factor										
HIV stigma towards PLWH/A			1.03	0.95-1.10	1.03	0.96-1.08	1.03	0.96-1.11	0.99	0.76-1.28
Stigma vs. Women's education (primary)									0.96	0.75-1.21
Stigma vs. Women's education (secondary)									0.99	0.79-1.25
Stigma vs. Women's education (tertiary)									0.79	0.58-1.06
Stigma vs. HIV knowledge									0.97	0.93-1.02
Stigma vs. Household wealth									1.01	0.92-1.11

Table 4 continued

Variable	Model 0	Model 1	Model 2	Model 3	Model 4	
	Empty model	**Individual variables**	**Community variables**	**State variable**	**Interaction variables**	
Stigma vs. Pre-test counselling					1.09	0.93-1.33
Random effects	**Empty**	**Individual**	**Community**	**State**	**Interaction**	
State-level						
Variance(SE)	0.79(0.21)***	1.02(0.14)***	1.02(0.28)***	0.88(0.25)***	0.88(0.25)***	
ICC=VPC (%)	16.6	20.2	20.5	18.1	18.2	
PCV (%)	Reference	29.1	0.0	13.7	0.0	
Community-level						
Variance(SE)	0.69(0.11)***	0.72(0.15)***	0.69(0.15)***	0.69(0.15)***	0.69(0.15)***	
ICC=VPC (%)	31.0	34.60	34.3	32.4	32.2	
PVC (%)	Reference	4.30	4.2	0.0	0.0	
Model fit statistics						
DIC	5225	3255	3212	3207	3199	
N	5164	3377	3345	3345	3345	

Abbreviations: SE= Standard Error, ICC= Intra-class correlation coefficient, CI= Confidence Interval, DIC= Deviance information criteria, VPC= Variance partition coefficient, PCV= Proportional change in variance, AOR: Adjusted odds ratios (derived from multivariate models where all variables were entered in the models simultaneously).

*******p<0.001; ******p<0.01; *****p<0.05.

+ marginal significant at 5%

Data source: 2013 NDHS.

Table 5 Identifying the effect modifying variables of the association between stigma and ANC-HIV testing

Model	Variable	β	SE	z-score	p-value
A	Stigma	*-0.099*	0.027	-3.690	0.000
B	Stigma	*-0.068*	0.027	-2.490	0.013
	Education: primary (RC: None)	0.108	0.133	0.810	0.419
	Secondary	0.436	0.128	3.400	0.001
	Higher	0.947	0.161	5.870	0.000
C	Stigma	*-0.059*	0.030	-1.970	0.049
	HIV knowledge	0.184	0.033	5.610	0.000
D	Stigma	*-0.052*	0.027	-1.900	0.057
	Wealth	0.556	0.060	9.230	0.000
E	Stigma	*-0.084*	0.027	-3.060	0.002
	Pre-test HIV counselling	0.819	0.098	8.380	0.000

Data source: 2013 NDHS

Appendices

Appendix A Result of principal component analysis for HIV/AIDS stigma

Variable	Observations(n)	Mean	Sd	Min.	Max.	Factor loading
Willing to care for relatives with AIDS	5162	0.75	0.43	0	1	0.36
A female teacher with AIDS should continue teaching	5160	0.69	0.46	0	1	0.49
Would buy vegetables from vendor with AIDS	5162	0.58	0.49	0	1	0.45
People with AIDS should be ashamed of themselves	5158	0.61	0.49	0	1	0.48
People with AIDS should be blamed for bringing the disease to the community	5160	0.59	0.49	0	1	0.44
Eigenvalue of the first component						2.2
Difference between first and second eigenvalues						0.95
Proportion of variance explained by the first component						0.44
Kaiser-Meyer-Olkin measure of sampling adequacy						0.64
Rho						0.69
Number of observations included in PCA						5148

Data source: 2013 NDHS

Appendix B Result of principal component analysis for HIV Knowledge

Variable	Observations(n)	Mean	Sd	Min.	Max.	Factor loading
Reduce HIV risk by always using condom during sex	5154	0.76	0.43	0	1	0.24
Reduce HIV risk by having one negative sexual partner only	5161	0.91	0.28	0	1	0.30
Can get HIV from mosquito bites	5159	0.77	0.42	0	1	0.5
Can get HIV by sharing food with person who has AIDS	5159	0.87	0.33	0	1	0.51
A healthy looking person can have AIDS	5134	0.81	0.39	0	1	0.18
Can get HIV by witchcraft or supernatural means	5156	0.74	0.44	0	1	0.49
Drugs to avoid HIV transmission to baby during pregnancy	4668	0.83	0.38	0	1	0.27
Eigenvalue of the first component						1.65
Difference between first and second eigenvalues						0.32
Proportion of variance explained by the first component						0.24
Kaiser-Meyer-Olkin (kmo) measure of sampling adequacy						0.62
Rho						0.43
Number of observations included in PCA						4617

Data source: 2013 NDHS

Appendix C Result of principal component analysis for Bargaining power

Variable	Observations(n)	Mean	Sd	Min.	Max.	Factor loading
Final say on own health care	4,817	0.58	0.62	0	2	0.56
Final say on making large purchases on the household	4,816	0.59	0.62	0	2	0.54
Final say on visits to families or relatives	4,825	0.73	0.65	0	2	0.51
Final say on what to do with the husband's salary	4,755	0.4	0.58	0	2	0.38
Eigenvalue of the first component						2.3
Difference between first and second eigenvalues						1.5
Proportion of variance explained by the first component						0.58
Kaiser-Meyer-Olkin measure of sampling adequacy						0.74
Rho						0.58
Number of observations included in PCA						4753

Data source: 2013 NDHS

Appendix D Result of principal component analysis for intimate partner's violence

Variable	Observations(n)	Mean	Sd	Min.	Max.	Factor loading
Ever been pushed, shook or thrown with something by husband	4,127	0.08	0.27	0	1	0.41
Ever been slapped by husband	4,129	0.15	0.36	0	1	0.39
Ever been punched with fist of hit by harmful object by husband	4,126	0.04	0.19	0	1	0.42
Ever been kicked or dragged by husband	4,127	0.06	0.24	0	1	0.4
Ever been strangled or burnt by husband	4,126	0.01	0.08	0	1	0.25
Ever been threatened with knife/gun /other weapon by husband	4.128	0.01	0.07	0	1	0.17
Ever been physically forced into unwanted sex by husband	4,128	0.05	0.22	0	1	0.25
Ever been forced into other unwanted sexual acts	4,127	0.02	0.12	0	1	0.2
Ever had arm twisted or hair pulled by husband	4,126	0.03	0.17	0	1	0.37
Eigenvalue of the first component						3.28
Difference between first and second eigenvalues						2.03
Proportion of variance explained by the first component						0.36
Kaiser-Meyer-Olkin (kmo) measure of sampling adequacy						0.81
Rho						0.62
Number of observations included in PCA						4112

Data source: 2013 NDHS